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Comandra Blister Rust of Hard Pines.

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Comandra blister rust[3] is a serious canker disease of hard pines caused by a native fungus *Cronartium comandrae* Pk. The disease is especially common in lodgepole pine in the Rocky Mountains, where it causes spiketops and mortality. It is common locally in ponderosa pine in the Rocky Mountains and along the east side of the Cascades. Long known on Table-Mountain pine in the northern Appalachians, this disease is now locally prevalent in seedling shortleaf pines of the Ozark Plateau and loblolly pine plantations on the Cumberland Plateau of eastern Tennessee. It is not known to occur outside of North America.

Distribution

Comandra blister rust[3] ranges generally from New Brunswick to the Yukon and British Columbia in Canada, and southward to California, New Mexico, and Alabama in the United States. In Western United States the fungus is present in all the States from the Rocky Mountains to the Pacific Ocean but is most common in Idaho, Montana, Utah, and Wyoming.

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Figure 1.—Comandra or bastard toadflax (*Comandra umbellata* ssp. *pallida*) in spring before rust infection. Numerous clumps of herbaceous shoots, usually about 5 to 10 inches high, grow annually from underground rhizomes. This plant is the alternate host of comandra blister rust.

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Hosts

Comandra blister rust is known on the following pines: jack, lodgepole, loblolly, Jeffrey, knobcone, pitch, ponderosa, Scots, shortleaf, Table-Mountain, and Virginia. Field evidence indicates that lodgepole, loblolly, and ponderosa pines are especially susceptible, while Jeffrey and knobcone are very rarely attacked. Some infections have been seen on Virginia pine, but its relative susceptibility is not yet known.

The fungus also alternates to the bastard toadflaxes or comandras (*Comandra umbellata*, fig. 1, and *Geocaulon lividum* of the Santalaceae family).

Life History

Cronartium comandrae has a life history very similar to that of the well-known white pine blister rust (*C. ribicola*). The fungus grows perennially in the living bark of pines and develops annually on stems and leaves of the herbaceous comandras.

The fungus infects needle-bearing shoots of pines in summer or early fall. Fungus strands (hyphae) spread between cells of the inner bark, and some become embedded between cells of the wood. One to three years after the initial infection, or even less under eastern conditions, small drops of a thick, somewhat sticky, reddish-orange liquid begin to exude from diseased bark during summer. These drops contain pycniospores that possibly function in the sexual phase of reproduction of the fungus. In the next growing season, orange spore pustules, called aecia (fig. 2), are produced over the area previously occupied by the pycnia.

These pustules, or blisters, break when mature and release great numbers of dark orange aeciospores which are disseminated by wind to infect the alternate host plants. Aeciospore production begins mainly in spring; reduced production continues throughout summer and into fall in the West.

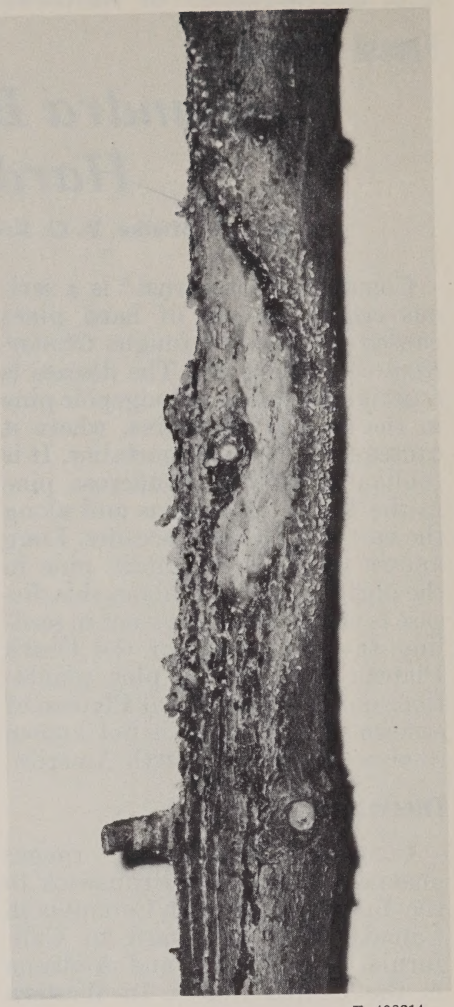

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Figure 2.—An aecia-bearing comandra blister rust canker on lodgepole pine. Aecia are the small light blisters appearing over a zone surrounding the area where the bark has been removed by rodents.

About 2 or 3 weeks following infection of comandra plants, yellowish blisterlike spots (uredia) about the size of a pinhead appear on the

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Figure 3.—**Leaf of comandra with scattered uredia of *Cronartium comandrae*. Dark structures near tip of leaf are young telia.**

leaves (fig. 3). Yellow urediospores are soon produced in these spots. These spores infect only other comandra plants, not pines. This is the repeating stage of the rust and serves to intensify the rust on the alternate host. Several generations of the urediospores may be produced during a single summer if moisture conditions are favorable.

About 1 to 3 weeks after uredia appear on the comandra plants, brownish hairlike structures called telia begin to develop. Telia grow to nearly 0.1 inch in length (fig. 4) and are composed of columnar masses of teliospores held together in a gelatinous matrix. In mild, wet weather, teliospores germinate in place to form delicate basidiospores. These basidiospores are airborne and are the only spores that can infect pines. Pine infection usually occurs in summer or early fall and

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Figure 4.—**Comandra shoot covered with abundant telia of *Cronartium comandrae*.**

completes the life cycle of the fungus.

Moisture and mild temperatures are needed for germination of all spore types produced by the fungus and for the subsequent infection of either host. Therefore, moist growing seasons often favor spread and intensification of comandra rust, but dry seasons discourage it. Since weather conditions favorable to each spore stage occur only in occasional years in the West, heavy pine infection is limited to wave years. Infection may be more frequent in areas such as the Appalachian Mountains, where summer rains are common.

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Figure 5.—Typical spindle-shaped comandra rust canker on main stem of a small ponderosa pine. The cracking and pitting of bark on swollen areas is caused by aecia rupturing the bark. Seedlings with infections on main stems survive only a few years.

Symptoms

The disease is first conspicuous on the pine host as a spindle-shaped swelling of the stem or shoot (fig. 5). Cankers originate on needle-bearing twigs and stems. The swelling, a thickening of the bark, is caused by a concentration of the fungus mycelium in the tissues and an increase in number and size of parenchyma cells. The diseased bark is not noticeably discolored.

The reddish-orange pycnial drops, first appearing in midsummer 1 to 3 years after initial infection, somewhat resemble resin drops and vary considerably in size; the largest are about 3/8 inch in diameter. They are easily washed away by rains and thus often escape notice.

During spring or early summer of the year following the appearance of pycnia and over the area they occupied, aecia push through the bark as orange blisters or pustules. When fully developed, the blisters rupture and reveal masses of dark orange aeciospores. New crops of pycnia and aecia may develop in the live bark at the edges of cankers for many successive years.

Cankered bark on which aecia are produced is cracked and pitted (fig. 5), and the cracks extend to the cambium. In time, branches and stems are girdled, causing the parts beyond the canker to die and their foliage to turn first yellowish and later reddish brown. Dead branches with the colored foliage still attached are known as flags. Spiketops result from girdling by stem cankers. Flags and spiketops are the most conspicuous symptom of the comandra rust until dead trees appear in infected timber stands.

Resin usually exudes abundantly from cankers in larger stem infections. Trunk cankers with an abundance of yellow dried resin are another conspicuous symptom of the rust, especially on lodgepole pine (fig. 6). The flow of resin often increases as a result of wounds inflicted by rodents, particularly squirrels and porcupines, which commonly feed on the infected bark. Such rodent activity is reason to strongly suspect the presence of the disease.

A microscopic characteristic of the comandra rust fungus that read-

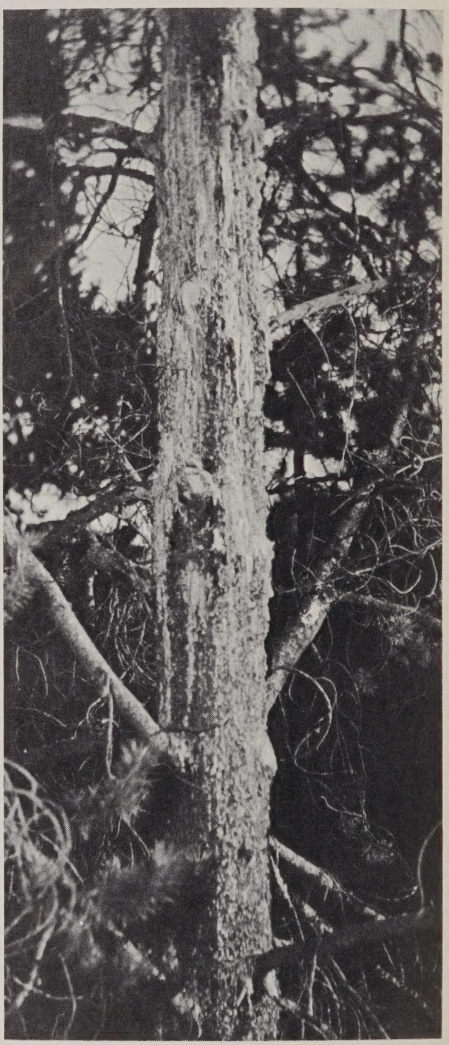

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Figure 6.—**A trunk canker on a large lodgepole pine exudes abundant resin. Resinosis and wounds caused by rodent chewing are conspicuous and common symptoms of the rust on this host.**

ily distinguishes it from all other rusts on pines is the teardrop shape of the aeciospores.

Damage

Comandra blister rust damage in a pine stand usually is not spectacular. The rust attacks trees of all sizes and ages. Seedlings may be killed in a relatively few years following infection because the rust fungus can infect needle-bearing parts of the main stems. This may lead to serious damage in young plantations of susceptible pines. In some infected loblolly pine plantations in eastern Tennessee, more than half the trees died within 2 years after planting.

But it takes a longer time to kill older trees, for the fungus usually enters their trunks by way of the branches, progressing only a few inches per year—and only while the branch remains alive. Therefore, the farther away from the trunk the branch infection occurs, the less likely the invasion of the trunk in a short time. Then, too, the rust progresses more slowly transversely than longitudinally. As a result, trunk cankers are usually more than twice as long as they are broad, and girdling of large trunks takes a long time. On older trees, the time between initial infection and death of the tree is sometimes 25 years and frequently considerably longer. For this reason, stands of mature pines in which the rust is epidemic often show little evidence of damage for many years. In the West all the eventual damage to a stand may result from trees becoming infected in the few years when the weather was favorable, or even in a single such year.

Stand damage differs greatly in intensity, depending on the susceptibility of the pine species, the climate, and the proximity and abundance of alternate host plants. Under favorable conditions, stands of ponderosa and lodgepole pines may be largely destroyed over limited areas. By contrast, scattered infection in overly dense young pine stands might even provide a beneficial thinning. Unfortunately, we cannot control rates of infection or limit the rust to local areas. Heavy infection has been found in lodgepole pine stands where the closest *Comandra umbellata* plants were more than a mile away.

Alternate Host Plants

In North American, *Comandra umbellata* is distributed from British Columbia to Newfoundland and southward to California, northern Mexico, and South Carolina. Although widely distributed, comandra is usually restricted to local occurrence in rather dry open habitats. In the West, it is rather commonly found in association with sagebrush or grasses and often on more exposed ridges. Occasionally, comandra is found in open stands of ponderosa pine but not beneath closed canopies of aspen or lodgepole pine. Eastward, habitats of comandra include grasslands, savannahs, and open oak or pine woodlands.

Three subdivisions of *Comandra umbellata* in North America are now recognized. All form annual herbaceous shoots from perennial rhizomes. Roots of comandra frequently parasitize but cause little harm to a wide variety of associated plants. All three forms of comandra are highly susceptible to *Cronartium comandrae*. Although comandra shoots are small, they are highly productive of pine-infecting inoculum. The combined telia of a single shoot commonly can produce more than a million basidiospores. Even a small amount of comandra near susceptible hard pines creates a serious potential hazard.

Geocaulon lividum, or northern

comandra, is found from Alaska to Labrador and southward into the northern parts of the border States of Maine to Minnesota and Idaho and Washington. It is usually found in more moist sites than comandra and mostly in moderately open woods. Northen comandra is probably less susceptible than other comandras to *Cronartium comandrae.*

Another form of *Comandra umbellata* occurs in the Balkan countries. Its presence constitutes a potential hazard to hard pines in that part of Europe. Other genera of the Santalaceae occur near hard pines outside North America. Their presence should be cause for concern, and measures should be taken to limit this potentially dangerous rust to its native range.

Control

Although there is no practical method to control comandra blister rust, damage from it can be minimized in several ways. Timber cutting operations should be concentrated in heavily diseased stands wherever possible. This makes possible the salvage of merchantable trees before they die and deteriorate from decay and other causes. Crop trees in infected stands of young ponderosa pine should be carefully examined for infections when selected during thinnings or other improvement cuttings, because undetected infections would eventually kill the selected trees. Maintaining large closed stands of trees and shrubs limits the potential habitat of comandra and has been the best natural protection of pines in the West. In areas where plantations have failed because of comandra blister rust, infected pines should be replaced with less susceptible species. Pruning infected branches would prevent most trunk infections that cause mortality and might be worthwhile in high-value recreational areas.

More direct methods of control have been suggested but are not operational at this time. Systemic antibiotics have been tried in lodgepole pine, but at most they only suppressed aecial sporulation and did not kill the fungus. Comandra plants have been grubbed out in the vicinity of plantations, but this method is not practical because of the extensive underground rhizomes. Numerous herbicides have been tested, but none have yet effected a satisfactory kill of comandra. The long-distance spread by basidiospores would make any comandra eradication program difficult.

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